Magnetic Observations.

Fortunately for the magnetic records secured at the observatory, the proposed electric tram-line in the neighbourhood of the Deptford Cattle Market has been successfully opposed. That this would have seriously damaged the records there can be absolutely no doubt, since it would have been only 1¼ miles from the observatory: even now small agitations, due to the running of trains on the South London Electric Railway, 4½ miles from the observatory, can be clearly traced from the year 1890 on the horizontal and vertical force sheets, synchronising with the disturbances in the earth current registers.

The principal results for the magnetic elements for 1897 are as follows:—

Mean declination	16° 50′·4 West.
Mean horizontal force by the Gibson instrument in the library ...	3·9877 (in British units). 1·8387 (in metric units).
Mean dip	67° 5′·5 (by 9-inch needles). 67° 6′·8 (by 6-inch needles). 67° 7′·1 (by 3-inch needles).

These results are to a certain extent affected by the iron in the new physical observatory and in the new altazimuth pavilion. To eliminate this effect as far as circumstances would allow, observations have been made during the past year on the site selected for the new magnetic pavilion in Greenwich Park, which is presumably free from any disturbing effect of iron. The horizontal force has been observed monthly on this site with the two deflection instruments (Gibson and Elliott), the declination occasionally with the Elliott instrument, and a dip with a Kew dip circle (Dover 74).

It appears from these observations that the declination at the observatory has been increased by 3′ to 4′ through the introduction of iron.

The mean horizontal force obtained with the Gibson instrument in the park is 1·8366 in metric units. In the same units we have also the following differences:—

Gibson in library—Gibson in park ...	+ 0·0021
Elliott in library—Elliott in park	+ 0·0084
Elliott in its usual position in library—Elliott on Gibson pier	+ 0·0060
Gibson in park—Elliott in park	+ 0·0010

All the magnetic disturbances during 1897 were of a comparatively trifling nature.

Meteorological Observations.

The mean temperature of the year 1897 was 50°·3, being 0°·9 above the average for the fifty years 1841–1890.

During the twelve months ending 1898 April 30, the highest daily temperature in the shade recorded on the open stand was 90°·2 on June 24. The highest reading recorded in the Stevenson screen was 87°·4 on the same day. The monthly mean temperatures were in excess of their corresponding averages in every month with the exception of May, September, and March. In January the excess amounted to 5°, the mean temperature for that month being 43°·6. In the preceding fifty-seven years there is one instance only of a higher mean temperature occurring in January, viz. in 1884, when it was 43°·9. A mean value equal to the present January value (43°·6) was also recorded in two other years (1875 and 1890). The winter of 1897–1898 was remarkably mild throughout, and the temperature of the air fell to freezing point (or below) on twenty-nine days only—ten of these occurring in March and seven in December. The lowest temperature recorded during the winter was 23°·3 on December 24. [The lowest temperature recorded in January was 30°·0.] The mean temperature for the five months 1897 October to 1898 February, was 44°·6, being 2°·4 in excess of the average value. During the whole period of fifty-seven years (1841 to 1897) this value has only been exceeded three times, viz. in the winter of 1876–1877, when the mean for the five months was 45°·8, in the winter of 1845–1846, when it was 44°·8, and in the winter of 1865–1866, when it was 44°·7. A mean value of 44°·6 (the same as that for the present year) was also recorded in the winter of 1848–1849, and in that of 1868–1869.

The number of hours of bright sunshine recorded during the twelve months ending 1898 April 30, by the Campbell-Stokes instrument, was 1529 out of the 4454 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·343, constant sunshine being represented by 1.

An interesting comparison is made between the results as given by the new and the old ball of the sunshine recorder for 1897. With the former 1542·6 hours were registered throughout the year, while with the latter only 1268·4 hours, the excess with the new ball amounting to 274·2 hours during the twelve months.

The rainfall for the year ending 1898 April 30 was 17·33 inches, being 7·21 inches less than the fifty years' average. The number of rainy days was only 149. This is a very small annual rainfall; the three smallest falls during the preceding fifty years being 16·38 inches in 1864, 17·61 inches in 1867, and 17·70 inches in 1858.

Personnel.

No change of any importance has been made with regard to the staff during the past twelve months, Mr. Dyson continuing to take special charge of the astronomical department, and Mr. Cowell the astro-physical department, in which is included the magnetic and meteorological branch.

GUTTA PERCHA.

IN a recent course of three lectures[1] delivered before the Society of Arts, and subsequently revised and reprinted from the *Journal* of the Society, with additional illustrations and appendices in the form of a bulky pamphlet, Dr. Obach dealt very fully with the history, origin, treatment and properties of gutta percha.

In the first lecture the early history, botanical derivation and geographical distribution of this substance were related, and the analyses of various commercial "brands," as well as exhaustive statistics of the annual imports and exports of the material were given.

In the second lecture the mechanical cleaning processes and chemical washing and hardening processes were described and illustrated, and also the different methods of extraction of gutta percha from removable parts of the trees, such as twigs and leaves, explained. This lecture concluded with an enumeration of the various *natural* substitutes for gutta percha which have been proposed at various times, including the interesting material known as *balata.*

The third lecture dealt with the mechanical and electrical properties of gutta percha and its application for various technical purposes, also its behaviour towards water, oxygen and ozone. In conclusion the *artificial* substitutes for gutta percha were briefly discussed.

The following is a short report on those parts of the third lecture which we think may be more especially interesting to the readers of NATURE.

In order to simplify matters, Dr. Obach selected from the numerous sorts of gutta percha which make their appearance on the Singapore market twelve different "brands," which may be considered as typical; they are distinguished by the name of the locality whence they are derived. For direct comparison and easy reference these twelve materials were divided into four groups, each group comprising materials more particularly related to each other. The groups were designated as "Genuine," "Soondie," "White," and "Mixed."

It was explained that cleaned gutta percha consists essentially of two constituents, viz. a hydrocarbon termed pure gutta (G) having the composition $C_{10}H_{16}$, and being therefore isomeric with oil of turpentine, and a resin (R) containing more or less oxygen, and consisting principally of two substances named Albane $C_{10}H_{16}O$, and Fluavile $C_{20}H_{32}O$. Besides these proximate components there is also a variable amount of extraneous matter present in every commercial gutta percha, even after the most scrupulous cleaning, which consists of finely-ground bark, wood fibres, vegetable colouring matter, grit, &c., summarily termed dirt (D), and of water (W).

Dr. Obach has found that the physical and mechanical properties of the various sorts of gutta percha depend almost exclusively on the relative proportion of gutta and resin, *i.e.* the ratio $\frac{G}{R}$, whereas the electrical properties depend chiefly on the nature of the gutta and, to a lesser extent, upon that of the resins, but also very largely upon the amount and the character of the impurities contained in the material.

---

[1] "Cantor Lectures on Gutta Percha," by Dr. Eugene F. A. Obach, F.I.C., F.C.S., M.I.E.E.

The specific gravity of cleaned gutta percha of average composition is very nearly the same as that of water, but that of individual brands deviates considerably from it, some being about 3 per cent. lighter, and others about 2 per cent. heavier, as will be seen from Table I., which gives the specific gravities for eleven definite brands and an average material obtained by mixing a number of different cleaned materials in the masticator. The table also gives for comparison the specific gravities of balata, of gutta percha extracted from leaves with petroleum spirit by Dr. Obach's patent process, and also of pure Para-caoutchouc.

The exceptionally low specific gravity of the gutta percha from leaves is to be attributed to the fact that it consists almost entirely of pure gutta.

TABLE I.—*Specific Gravity of Cleaned Gutta Percha.*
(2·2 mm. sheet.)

Group	Name of brand	Spec. grav. at 15° C.	Ratio $\frac{G}{R}$
I. Genuine	Pahang	0·9858	3·9
	Banjer red	0·9868	4·0
	Bulongan red ...	0·9911	3·4
II. Soondie	Bagan	0·9709	1·44
	Kotaringin	0·9729	1·30
	Serapong	0·9767	1·38
III. White	Bulongan	1·0093	1·57
	Mixed	1·0186	1·14
	Padang	0·9911	1·40
IV. Mixed	Padang reboiled ...	0·9960	1·18
	Sarawak mixed ...	0·9912	1·20
	Mixed after cleaning	1·0022	1·75
V. Various	Balata	0·9731	1·16
	G.P. from leaves ...	0·9625	51·90*
	Para-caoutchouc ...	0·9275	—

* Not 5·19, as erroneously stated in the *Journal* and Reprint.

The absorption of water by gutta percha was ascertained by immersing strips of the cleaned material in water and weighing them at regular intervals for about eighteen weeks. The results of these tests made on representative materials of the four groups which have been mentioned, and on gutta obtained from leaves, on balata and caoutchouc, are graphically shown in Fig. 1.

The curves shown on the left of the diagram (Fig. 1) represent the average results obtained for the different brands composing the various groups or "classes," as well as the results for gutta percha extracted from leaves, for balata, and also for pure Para-caoutchouc; but the curves on the right of the diagram were indirectly obtained by calculation and represent the absorption, which would have taken place if each specimen tested had entirely consisted of the kind of gutta which is characteristic of it. The reason for this reduction of the results to "pure gutta" is that the water is exclusively absorbed by this component and not by the resin, which has been found impervious to it.

It will be seen from the diagram, that it is the group of "genuine" materials which absorbed the most water, both before and after the reduction to "pure gutta"; whereas of the materials as such, it is the "white" sorts which are the least permeable to water, and of the "pure guttas" that of the material extracted from leaves.

Pure Para-caoutchouc, as is generally known, has a considerably greater absorptive power for water than even the most permeable kind of gutta percha.

The temperature at which gutta percha becomes plastic, a physical property of practical importance, depends almost entirely upon the relative proportion of gutta and resin. The great difference existing in that respect between the different sorts was demonstrated in the lecture by an experiment illustrated in diagram (Fig. 2).

The apparatus consists of a frame, *f*, holding three strips of gutta percha, 1, 2, 3, under the tension of springs S_1 S_2 S_3, the frame is lowered into a beaker of water, V, and the latter slowly heated, the arrangement being such that an electric current is established, and an alarum, A, sounded as soon as a strip becomes sufficiently soft to allow the spring to pull it apart. The three materials employed contained 2½, 38 and 60 per cent. of resin, and the temperatures at which they softened were found to be 55°, 48° and 42° C. respectively.

Another physical property, viz. the time required by gutta percha to harden or set again on cooling, after having previously been softened by heat, also depends mainly on the relative percentage of gutta and resin, as was pointed out by the lecturer.

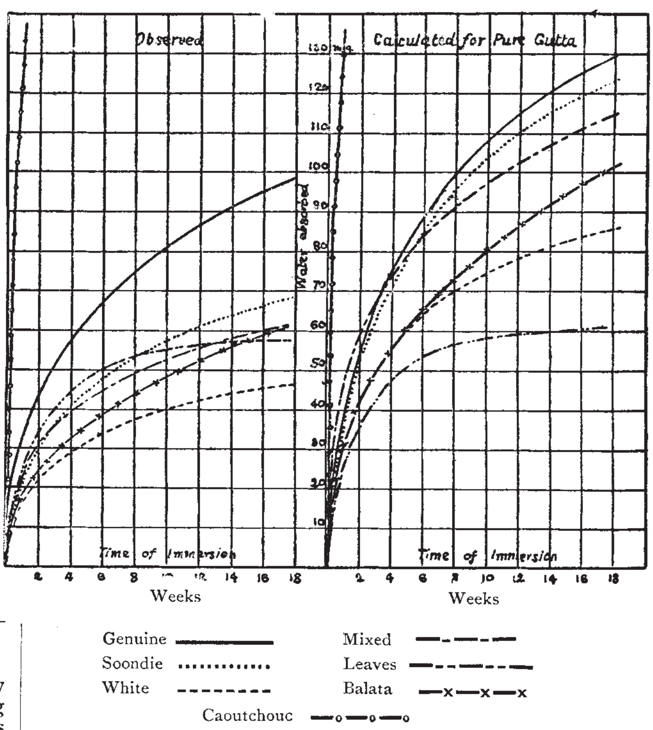


FIG. 1.—Absorption of water by different "classes" of gutta percha. (Thickness of sheet 2·2 mm.; area, 1 sq. dm.; weight, 10 g.)

The mechanical properties of gutta percha, of which the tensile strength is the principal one, are in their turn also greatly affected by the percentage of resin.

The important electrical properties of gutta percha chiefly depend on the nature of the gutta, and, to a lesser extent, on that of the resin, but only slightly on the relative proportion of these two components.

The insulating property of gutta percha was stated to have been first observed by Dr. Werner von Siemens in 1846. Faraday also noticed it shortly afterwards, and called attention to it in March 1848.

Dr. Obach showed the two principal electrical properties by means of an electroscope arranged as shown in Fig. 3. The instrument was provided with a flat brass disc, P, at the top, and below it two pith rods, *p*, *p*, were suspended on either side of a fixed strip of brass, *m*. When a piece of gutta percha tissue was spread over the brass disc and the electroscope charged by means of the brass knob, *k*, at the side, the pith rods diverged and remained stationary. If the fingers were now placed on the covered disc, the rods slightly converged and then again remained stationary. On withdrawing the hand, the rods took up their former diverged position.

This simple experiment demonstrated at once the excellent insulating property of gutta percha and its inductive capacity. Its insulating power was shown by the fact, that the tissue formed an efficient screen between the hand and the brass disc of the electroscope, to prevent the latter from being discharged. Its inductive capacity was shown by the temporary fall of the pith rods, indicating the "binding" of the charge on them when the tissue was touched by the hand.

Per se the insulation of gutta percha should be as high as possible, and the inductive capacity as low as possible; but whereas the latter property is mostly associated with other good qualities of the material, such is not always the case with a high insulation.

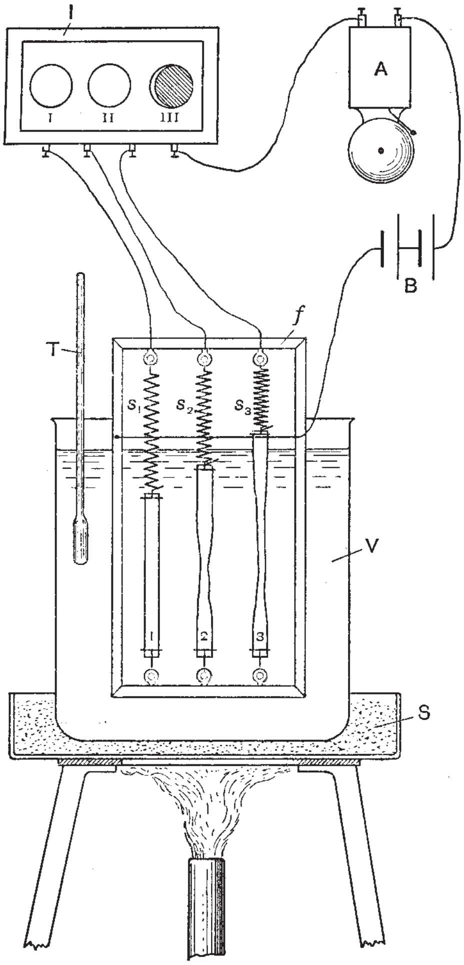


FIG. 2.—Softening temperature of gutta percha.

Faraday apparently had some difficulty in 1848 in obtaining gutta percha having a sufficiently good insulation. He found that this was due to an excessive amount of water contained in the commercial material. This is an important matter, and experiments were shown by Dr. Obach to demonstrate the effect of different percentages of water on the insulating power of gutta percha. The electroscope was charged until the rods fully diverged. Strips of gutta percha, containing approximately 15, 10, 5 and 2½ per cent. of water, were then successively brought into contact with the brass knob, the finger being held against the other side of the strip. When the strip containing 1·5 per cent. of water was brought into contact with the knob, the pith rods slowly converged, and did not regain their former position on removing the strip, which showed that the charge had been dissipated. On repeating the experiment with the next strip, containing 10 per cent., the charge disappeared much more slowly; the strip containing 5 per cent. of water was next tried, and this was found to be an almost perfect insulator and practically equal to the best strip with 2½ per cent. of water. It must be mentioned however, that different sorts of gutta percha behave differently in this respect. The specific insulation and inductive capacity of various specimens of gutta percha are given in a table in comparison with other materials, such as paraffin wax, colophony, ebonite, &c., but space does not permit us to reproduce this interesting table here. The figures show how greatly the electrical data vary for different kinds of gutta percha. For instance, the insulation resistance per cube knot was only 382 megohms for an otherwise excellent specimen of gutta percha, and 139,300 megohms for a specimen of considerably inferior description. Gutta percha extracted from leaves has usually a comparatively high insulation, exceeding that of paraffin wax, colophony and ebonite, but the insulation resistance of pure vulcanised caoutchouc is higher still, approaching the maximum obtained with ordinary gutta percha. The specific inductive capacity also varies greatly, the lowest values per cube knot being ·0466 and the highest ·0801 microfarad. In this respect the gutta obtained from leaves by Dr. Obach's process compares favourably with any ordinary gutta percha. Pure Para-caoutchouc also has a very low inductive capacity, viz. ·0446 mfd., which is lower than that of the best gutta percha, but paraffin wax is lower still, viz. only ·0411 mfd. Water, on the other hand, has the highest known inductive capacity of any substance, *i.e.* 1·348 microfarad per cube knot. The significance of this will be seen on comparing the values in Table II., which gives the insulation and inductive capacity of several "brands" of gutta percha, each with a high and low percentage of water.

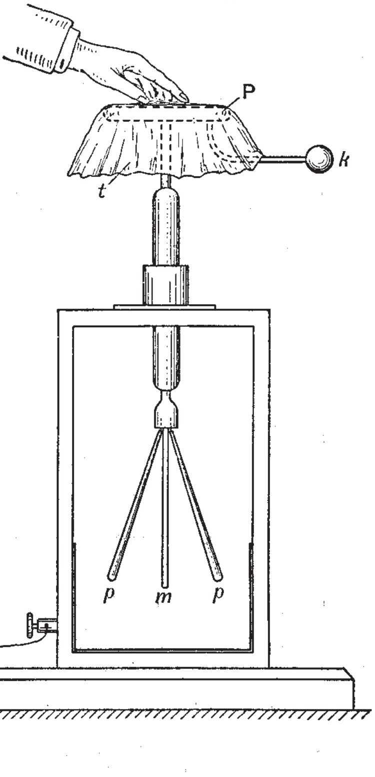


FIG. 3.—Insulation and electrostatic capacity of gutta percha.

The dielectric strength of insulating materials is another property, which is daily becoming more important. From tests made on gutta percha-covered cores of submarine cables, it has been found that a thickness of $\frac{1}{8}$ inch of this dielectric is pierced by about 40,000 volts, and one of $\frac{1}{10}$ inch by about 28,000 volts.

The next table (III.), which is abstracted from a large table in the *Journal*, contains the chemical composition and the physical, mechanical and electrical properties of the first grades of the twelve principal brands of gutta percha.

The figures show how largely the physical and mechanical properties depend on the relative proportion of gutta and resin, *i.e.* the ratio $\frac{G}{R}$. The temperatures given as those at which the material softens and at which it becomes pliable, have only a relative value, as they apply to the particular method of testing here employed, but for comparative purposes they are most valuable.

TABLE II.—*Insulation and Induction per Cube Knot with Low and High Percentage of Water.*

(Abstracted from larger table.)

Percentage of water.	I. Genuine. (Pahang)			II. Soondie. (Bagan.)			III. White. (Banjer.)			IV. Mixed. (Sarawak.)		
	Water p.c.	Insul. megs.	Induct. mfds.	Water. p.c.	Insul. megs.	Induct. mfds.	Water. p.c.	Insul. megs.	Induct. mfds.	Water. p.c.	Insul. megs.	Induct. mfds.
Low	1·5	6,173	·0523	1·7	7,950	·0521	0·6	10,410	·0555	1·1	24,250	·0564
High	6·3	5,480	·0675	7·3	4,350	·0682	7·1	6,454	·0898	7·0	24,250	·0718

The softening temperature is determined as follows:—A thin sheet of the gutta percha to be tested is very slowly heated in a water bath, and a small stud from time to time brought to bear upon it with a definite pressure. As soon as the stud leaves a permanent impression on the surface of the sheet, the temperature of the water is noted and recorded as the "softening temperature."

TABLE III.—*Chemical Composition, Physical, Mechanical and Electrical Properties of the First Grades of Twelve Different "Brands" of Gutta Percha.*

(Abstracted from larger table.)

	Name of brand	Percentage composition					Temperat. (° C.) when G.P. becomes		Time of hardening in mins.	Tensile strength. Lbs. per sq. inch.	Elongation during breaking test per cent.	Insul. resist. per cube knot at 75° F. after 2nd min. in megohms	Induct. capac. per cube knot in microfarads
		G	R	D	W	$\frac{G}{R}$	Soft	Plastic					
I. Genuine	Pahang	80·0	17·7	1·4	0·9	4·52	48·8	66·1	$2\frac{3}{4}$	5,067	444	1,077	·0511
	Banjer red	70·5	26·9	1·4	1·2	2·62	45·0	67·2	5	4,123	417	3,723	·0542
	Bulong red	73·4	24·2	1·4	1·0	3·03	46·1	64·4	4	4,200	440	4,511	·0537
II. Soondei	Bagan	57·7	40·6	1·0	0·7	1·42	40·0	61·6	9	2,528	383	10,800	·0523
	Kotaringin	57·8	40·3	1·2	0·7	1·43	40·0	61·1	12	2,443	383	3,284	·0541
	Serapong	57·5	41·0	1·0	0·5	1·40	41·1	60·5	12	2,466	390	35,180	·0536
III. White	Bulongan	52·5	45·0	1·5	1·0	1·16	41·6	70·0	18	2,537	420	46,380	·0581
	Mixed	52·0	46·0	1·2	0·8	1·13	42·7	78·8	19	3,180	418	86,550	·0541
	Banjer	53·6	42·9	1·7	1·8	1·25	43·3	75·0	24	3,026	406	45,780	·0612
IV. Mixed and Rebd.	Saraw. mix.	61·3	35·1	2·0	1·6	1·75	42·7	65·0	12	2,572	397	12,330	·0602
	Pad. rebd.	50·3	45·7	1·5	2·5	1·10	36·6	61·6	63	1,465	475	16,840	·0649
	Banca rebd.	47·1	50·5	1·3	1·1	0·93	38·8	63·3	54	1,552	371	71,380	·0577

Note.—Each series of figures in this table represents the average result obtained with a number of individual lots of the particular brand.

The temperature at which the material becomes pliable is thus determined:—A strip of the material of definite dimensions is held vertically in a bath of water; the upper end of the strip is attached to a cord, passing over a pulley and carrying a known weight, the strip being thus subjected to a constant tension. The temperature of the water at the moment when the weight is able to pull the strip asunder, is taken as that of "pliability."

The "time of hardening" is that taken by the material, heated to the temperature of pliability, to become sufficiently rigid to resist the pressure of the stud in the apparatus used for determining the softening temperature, the water surrounding the strip being maintained at 75° F.

With a view to investigating the action of oxygen on cleaned gutta percha more thoroughly than had hitherto been done, Dr. Obach conducted an exhaustive series of experiments having for their special object a direct comparison of the avidity with which the different "brands" of gutta percha absorbed oxygen under similar conditions. For this purpose small spheres, of 2 cub. cm. contents and 8 sq. cm. superficial area, were enclosed in glass tubes filled with oxygen and inverted over mercury troughs. The tubes had a capacity of about 30 cub. cm., and each contained two spheres. They were refilled as soon as the composition of the residual gas approached that of the air, the oxygen used containing about 7 per cent. of nitrogen. The mercury troughs were placed outside a window on the south front of the laboratory exposed to full sunshine. The experiment extended over twenty-four weeks, and during that period the total amount of bright sunshine amounted to 680 hours.

The smoothed curves, given in Fig. 4, show the average amount of oxygen in cub. cm. absorbed by each of the four different groups of materials and for comparison, also that absorbed by gutta percha obtained from leaves and by balata. As in the case of the experiments on the absorption of water, two sets of curves are given—one representing the absorption of oxygen by the materials as tested, and the other the absorption calculated for "pure gutta," since here also it is mainly this constituent by which the absorption takes place.

The appendix to the lectures, given in the reprint, contains the results of a complete chemical analysis of the identical specimens of gutta percha used for the determination of the specific gravity and the experiments on the absorption of water and oxygen.

Experiments were also shown to demonstrate the remarkable difference in the behaviour of gutta percha and caoutchouc towards ozone, thin tissue of the former resisting the action of strongly ozonised oxygen for a considerable time, whereas a caoutchouc membrane was pierced by a jet of this gas impinging on it in a few moments. The lecturer also spoke of the applications of gutta percha hardened by extraction of the resin according to his process, proposing it for the use of boats for the arctic regions, on account of its considerably greater strength than that of ordinary gutta percha at very low temperatures, which was demonstrated by experiments.

He also showed that the elasticity of golf balls, as shown by the height of rebound when allowed to drop on a stone slab, depended almost entirely on the percentage of resin in the gutta percha of which they are made; and consequently the treatment by the hardening process is now invariably resorted to, except in the case of gutta percha obtained from leaves by chemical precipitation processes, which consists almost entirely of pure gutta, as has been already mentioned.

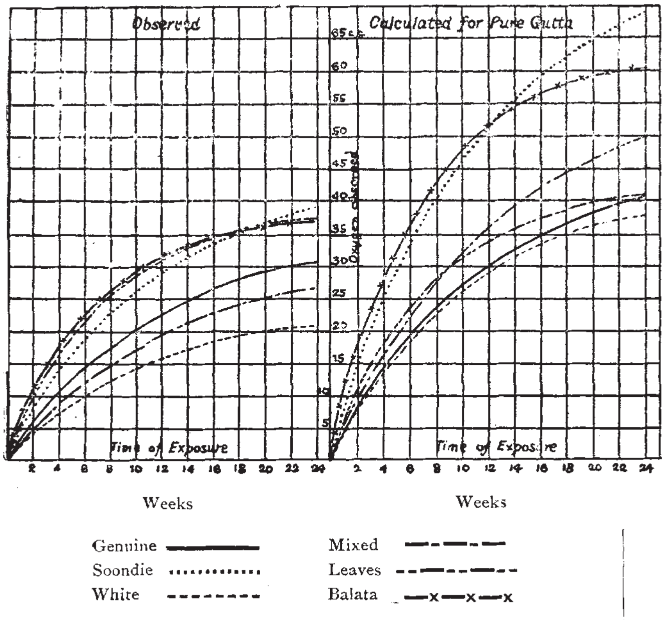


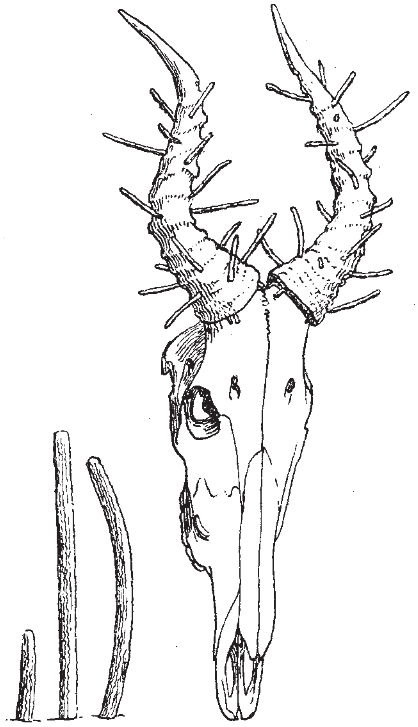
Fig. 4.—Absorption of oxygen by different "classes" of gutta percha. (Two spheres, each 16 mm. diam.)

HORN-FEEDING LARVÆ.

Some few months ago I received a consignment of skulls of antelopes from West Africa, the specimens having been shot by the late Lieut. R. H. McCorquodale, 3rd Dragoon Guards, and on opening the cases I was much struck by the appearance of the horns; all, without exception, were infested by singular thin finger-like protuberances which seemed to grow from the horn, leading me at a first impression to the immediate conclusion that they were some species of fungi; on a nearer inspection I found them to be cocoons, and not having seen anything like them before I looked into what literature I could find on the subject.

As it is, generally speaking, only travellers, or those in touch with travellers, who have the opportunity of seeing the actual cocoons on the horns, a sketch and a few salient points will doubtless be of interest. The skull, that of a Hartebeest, was exhibited at the Linnean Society on January 20 last, and is the original of the sketch; the cocoons are cylindrical and closed at the outer end like the fingers of a glove, extremely tough and composed of a dark grey felt substance, evidently the comminuted fibres of horn, the largest being about three inches in length; these cocoons are formed by the horn-feeding larvæ of the moth known as the *Tinea vastella*, and the following is a description of the insect:—Very pale gilded ochraceous shining. Head ochraceous and tufted above, palpi porrect, pubescent, extending a little beyond the front, much shorter than the breadth of the head, third joint lanceolate, much shorter than the second. Abdomen extending much beyond the hind wings. Legs rather long, hind tibiæ thinly fringed. Wings long, narrow, fringe rather long, fore wings slightly acute, exterior border very oblique, under side and hind wings purplish cinereous, excepting the fringe. Length of the body seven lines, of the wings sixteen lines.

A very interesting point with regard to the habits of this insect, which has not yet been cleared up, but upon which I hope to be able to throw some light, through the observations of officers now serving in Africa, is, that it has been asserted to feed on the horns of living animals; and in support of this I will quote the following:—"Dr. Fitzgibbon many years ago while in Gambia stated he was surprised at finding grubs enclosed in cases, which projected from the horns of animals freshly killed, the blood not being yet dry, the carcases of the animals being exhibited in the market place." This statement is recorded in vol. i. of the *Proceedings* of the Dublin Zool. Soc. "In contradiction, Lieut.-Colonel Wenman Coke said he had shot large numbers of various species of horned animals in South Africa, but that he had never seen the horn of a living animal perforated by one of these larvæ, although he had seen many dead horns infested with them. Colonel Coke is most confident that the larvæ never attacks a living animal; he says that had this been the case it could not have escaped his observation; Mr. Truman concurs in expressing great doubt as to the correctness of the theory that the larvæ feed on the horns of living animals." We have the strong evidence of Dr. Fitzgibbon, and might argue that, as the fibrous substance of the horn undergoes little or no change at the death of the animal, there seems no reason why the moth should not deposit its eggs



Cocoons ½ natural size. Skull and horns ⅛ natural size.